8. In no species of this formation is the fourth inferior premolar like a molar tooth.

It is thus evident that the dentition of the mammalia of the Puerco fauna presents a much greater degree of simplicity than does that of the species of any of the later Eocene or other age. This result coincides with the results I have already obtained from a study of the structure of the feet, etc.* These may be summarized again as follows:

1. The species in which the number of toes is known, have them 5-5.
2. Those in which the feet are known are plantigrade.
3. No species is known to have interlocking carpal and tarsal bones, excepting the two species of *Pantolambda* (carpus unknown).
4. No species is known to have well grooved astragalus (its presence is inferred in two species of *Dissacus*).
5. No species is known to have a faceted radius or ulno-radius, adapted to the separate carpal bones of the proximal row.
6. In no species is the tongue in the metapodio-phalangeal joints developed on the front of the metapodial bones.
7. The zygapophyses where known are all flat, except in some species (probably all) of *Oxyclænus*, where they are simply convex-concave, and not doubly so.

On the Trituberculate Type of Molar Tooth in the Mammalia. By E. D. Cope.

(Read before the American Philosophical Society, December 7, 1883.)

It is now apparent that the type of superior molar tooth which predominated during the Puerco epoch was triangular or tritubercular; that is, with two external and one internal tubercles.† Thus, of sixty-seven species of placental mammalia of which the superior molars are known, all but four have three tubercles of the crown, and of the remaining sixty-five, all are triangular, excepting those of three species of Periptychus, and three of Conoryctes, which have a small supplementary lobe on each side of the median principal inner tubercle.

This fact is important as indicating the mode of development of the various types of superior molar teeth, on which we have not heretofore had clear light. In the first place, this type of molar exists to-day only in the insectivorous and carnivorous Marsupialia; in the Creodonta, and the tubercular molars of such Carnivora as possess them (excepting the plantigrades). In the Ungulates its persistence is to be found in the molars of the Coryphodontidæ of the Wasatch, and Dinocerata of the Bridger Eocenes. In later epochs it is occasionally seen only in the last superior molar.

It is also evident that the quadritubercular molar is derived from the tritubercular by the addition of a lobe of the inner part of a cingulum of the

* American Naturalist, 1883, p. 1056; Science, 1883, p. 275.
† See American Naturalist, April, 1883, p. 407.

posterior base of the crown. Transitional states are seen in some of the Periptychidæ (*Anisonchus*), and in the sectorials of the Procyonidæ.

The tritubercular or triangular superior molar is associated with a corresponding form of the anterior part of the inferior molar. This kind of inferior molar* I have called the tubercular sectorial, and is very variable as to the degree of development of the sectorial cutting edge. The anterior triangle is formed by the connection by angle or crest, of the median and anterior internal crests with the anterior external. Its primitive form is seen in Didelphys, Pelycodus, Pantolambda and the Amblypoda generally; in Centetes and Talpa; and in its sectorial form, in Stypolophus and Oxyæna, etc.

The mechanical action of such teeth is as follows: Of course, it results from the form of the superior molars that the spaces between them are wedge-shaped, the apex external, the base opening to the palate. The base of the triangular section of the anterior part of the inferior molar is interior, and the apex exterior, and when the jaws are closed, this triangular prism exactly fits the space between the superior molars. The lower heel of the inferior molar receives the impact of the crown of the superior molar. Thus the oblique edges of the inferior triangle shear on the edges of two adjacent superior molars. The anterior parts of the inferior molars, and the superior molars, form an alternate dental series as distinguished from the prevalent opposed dentition of most mammalia. In so far it resembles the reptilian dentition.

This primitive dentition has been modified in two directions; viz., to form the grinding and the sectorial dentitions. As already remarked, the superior molars gradually acquire a posterior internal lobe, which produces the quadritubercular type. This lobe, by opposing the anterior internal lobe of the next posterior inferior molar, precludes the entrance of the anterior triangle of the latter between the two superior molars. Hence we find in the types which possess quadritubercular superior molars, that the anterior triangle of the inferior molar is not elevated, if present, as for instance in Rhinoceros. It is, however, more frequently atrophied, and disappears, forming the inferior quadritubercular molar so well known.

On the other hand, as I have pointed out,† the anterior internal cusp of the triangle of the inferior molar may be more developed anteroposteriorly, giving the antero-internal edge of the triangle much greater obliquity than the postero-internal. In correspondence with this modification, the superior triangular molar loses its equilateral character by the more anterior position of its internal angle, thus elongating the posterior internal side of the crown. The latter thus fits the corresponding form of the triangle of the inferior molar, forming with it the shear of the sectorial tooth.

*See Report G. M. Wheeler, D. Chief of Engineers on Explor. Surv. W. 100th Mer. Vol. IV, pt. ii; on the Creodonta.

†On the origin of the sectorial tooth of the Carnivora, American Naturalist, 1875.

In a former article, "On the Homologies of the Molar Teeth," etc., I traced the modifications of the superior and many of the inferior molars of the ungulate mammals to a parent quadrituberculate type. In a subsequent essay* I traced the origin of the inferior sectorial to a primitive five-tubercled, or "tubercular sectorial" type. Farther than this I did not go, and made no attempt to derive the few cases of triangular superior molars then known, nor the type of the superior sectorial. The revelations of the Puerco fauna show, that the superior molars of both ungulate and unguiculate mammalia have been derived from a tritubercular type; and that the inferior true molars of both have been derived from a "tubercular sectorial" type. Shall we look for the origin of the latter in a tritubercular tooth also, *i.e.*, tubercular sectorial without heel; and will the crowns of the true molars of the primitive mammals alternate with, instead of oppose each other? This is a probable result of future discovery.

On the Synchronous-Multiplex Telegraph. By Prof. Houston.

(Read before the American Philosophical Society, December 7, 1883.)

Prof. Houston said: "It is with considerable pleasure, Mr. President and gentlemen, that I am here this evening to call your attention to a discovery in electricity that appears to me to be of very great practical value to the world. The present decade has witnessed such marvelous progress in electrical inventions that many of us have perhaps been disposed to believe that but little new could reasonably be expected, but, unless I am greatly mistaken, the invention which I am about to describe to you, is greater even than that of the telephone.

"Before proceeding to the details of the invention of the synchronous-multiplex telegraph system of Mr. Patrick B. Delany, it will, perhaps, be best that your attention should first be called to some of the practical purposes for which it is applicable. Briefly stated, the value of this invention is to be found in the fact, that by its use the simultaneous transmission of numerous telegraphic dispatches over one and the same wire is readily accomplished. Hitherto, the only system that accomplished this, to any considerable extent, in actual practice, was the quadruplex system, and this, as you well know, is not only limited to the simultaneous transmission of four dispatches, but these are necessarily sent, two each, in opposite directions. You will, therefore, readily understand the great value of Mr. Delany's wonderful invention, when I inform you that not only can the number of simultaneously transmitted dispatches be very greatly increased, even indeed as far as seventy-two, but that all of them can be sent in the

*Journal Academy Natural Sciences, Philadelphia, March, 1875.